In vacuo detection of XUV photons at the ESR using a movable cathode system*

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The Institut für Kernphysik in Münster is currently developing a system for in-vacuum detection of XUV photons in the wavelength range from < 10 nm up to about 250 nm. The system will be installed at the ESR and consists of a movable cathode plate with a central slit that can be positioned around the ion beam axis to catch photons emitted in the forward direction during the de-excitation of stored highly-charged ions. Secondary electrons emitted from the cathode will be guided by a system of ring electrodes to a multi-channelplate (MCP) detector placed inside the vacuum. A similar detection system for optical photons making use of a movable parabolic copper mirror and a photomultiplier outside the vacuum, has successfully been applied in the detection of the HFS transition in lithium-like bismuth in the LIBELLE experiment two years ago [1, 2]. There it was demonstrated, that the introduction of a suitable optical system at the beam position does not disturb the stored ions apart from a small loss in beam current during the movement of the system.
Figure 1 displays the result of a tracking simulation produced with the SIMION [3] package. Five ring electrodes are placed between the cathode plate and the MCP, with the first electrode parallel to the cathode. The CF200 port into which the system can be retracted during injection of ions into the ESR actually acts as an additional sixth electrode on ground potential, but has been omitted from the figure for clarity. In the simulation, more than 75% of the secondary electrons emitted from the cathode plate are collected by the MCP.
The new detection system will be used for a measurement of the ${}^3\mathrm{P}_0-{}^3\mathrm{P}_1$ splitting in beryllium-like krypton in an anti-collinear laser spectroscopy experiment at the ESR [4]. The meta-stable state $(1s^22s2p)^3\mathrm{P}_0$ (see figure 2) is populated during the production of the ${}^{84}\mathrm{Kr}^{32+}$ ions. For the excitation to the $(1s^22s2p)^3\mathrm{P}_1$ state, a laser-beam is injected anti-collinear to the ions which are stored at a velocity of $\beta = 0.69$. Due to the Doppler shift, the required wavelength is red-shifted from 118 nm to 276 nm. The photons emitted during de-excitation to the ground state in the forward direction are in turn blue shifted to energies up to 170 eV.

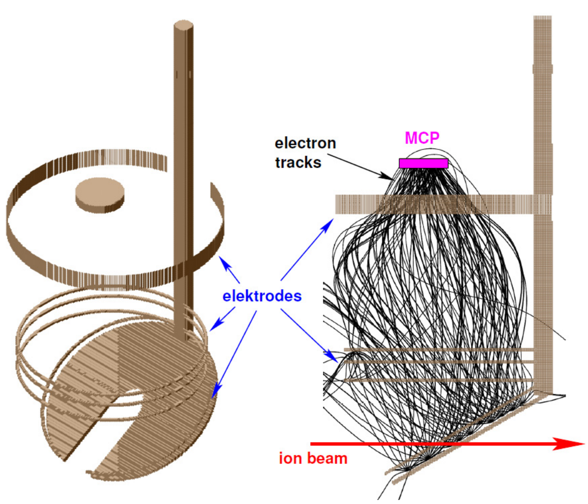

Figure 1: Electrode representation and simulated electron tracks calculated with the SIMION package.

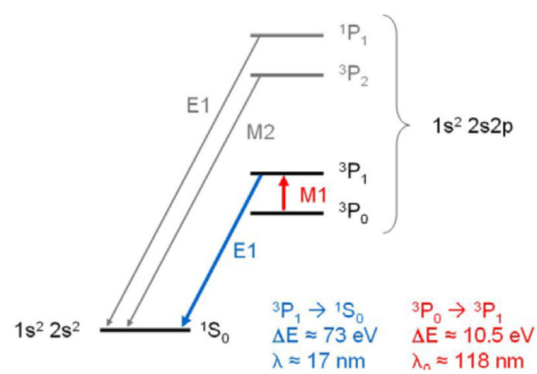

Figure 2: Excerpt of the level-scheme of beryllium-like krypton.

References

[1] M. Lochmann *et al.*, GSI Scientific Report 2011, PNI-AP-01

[2] J. Mader *et al.*, GSI Scientific Report 2011, PNI-AP-24

[3] SIMION package, Scientific Instrument Services, Inc., http://simion.com

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